Usability Analysis using Principal Component Analysis (PCA) Method for Online Fish Auction Application

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***Abstract*— Information systems or applications that are implemented and used by users need to go through top-level analysis, according to the needs of information systems or applications that can be used. Testing and usability analysis and user engagement scale needs to be done to measure the level of usage of the online fish auction application. This analysis uses the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity methods for testing validity. And use the Principal Component Analysis method for dimension factors that represent all dimensions. Indicator test results show some of the most important variables, namely PUS5 and FI3 with the largest values of 0.926 and 0.792, which are indicators that represent the variables of Engagement (Perceived Usability and Felt Involvement).**

Keywords—usability, user engagement scale, principal component analysis, fish auction

I. INTRODUCTION

Android-based online auction system called "Bidfish" is an online fish auction application that can help Fish Auction Sites or "Tempat Pelelangan Ikan" (TPI) to hold fish auctions.

The main service offered by the BidFish application is the real-time auction feature to determine the highest prices offered by customers. The main feature supporting services are the deposit feature, the bidders registration feature, and the print proof of the auction winner

To measure user interest and user involvement in this application, the user engagement scale is used. The questionnaire used in the user engagement scale serves to evaluate how difficult or easy it is to use, besides the user engagement scale also determines whether the application is feasible or not applied in the community. This test is carried out directly with the target user to measure how intuitive and easy a software is for them to achieve the intended use of the application. This research will use Principal Component Analysis (PCA) data analysis methods. PCA is simple, using non-parametric data to extract relevant information from the relevant data set from the data set so that it is suitable for use in this study. In this study, the Principal Component Analysis method with the Eigenvalues Decomposition approach is applied as a data analysis method with the aim of testing the usability of the Bidfish application in accordance with the User Engagement Scale test.

II. LITERATURE REVIEW

A. BidFish Indonesia

BidFish Indonesia [1] is an online fish auction application that is used to help a government service at the Fish Auction Place. BidFish fish auction activities are expected to be a platform that can facilitate auctioneer work in streamlining time in auction activities, as well as facilitating customers to get better and broader communication access without having to come to the venue.

B. User Engagement Scale (UES)

User Engagement Scale is a questionnaire designed to measure user interest and involvement, consisting of 31 items and 6 subscales namely aesthetic appeal, novelty, feeling of involvement (perceived Usability), matters of focus that become attention (Focused attention), perceived ease of use (felt involvement), and endurability [2].

1. Focused attention (FA): Is the user's concentration when surfing in cyberspace
2. Perceived Usability (PUS): Is the user's affective and cognitive response to the system
3. Aesthetic appeal (AE); Is the user's perception of the appearance of a system interface
4. Novelty (NO): Represents the level of wanting to know the user of the system Felt involvement (FI): Represents the feeling felt by the user when surfing in cyberspace
5. Endurability (EN). [3].

Overall evaluation is carried out to find out how users feel about this application [3].

C. Principal Component Analysis (PCA)

Principal Components Analysis (PCA) is a tool in the analysis of modern data in various fields from neuroscience to statistical analysis of information systems, because the PCA method is considered simple, using non-parametric to extract relevant information from data sets [4]. According to Shlens [4] in his research, with a minimum effort PCA provides a road map for how to reduce a complex data set to a lower dimension to reveal hidden structures on a simplified basis. PCA has the following equation:

$$\hat{\mathrm{X}}k = \mathrm{X} - \sum_{s=1}^{k-1} \mathrm{X} w_{(s)} w_{(s)}^{T} \quad (1)$$

Note that according to Zanoli et al. [5], this technique is based on a mathematical procedure of changing the number of indicators in a variable that might correlate with other variables, into even simpler variables.

D. Eigenvalues Decomposition (EVD)

Properties in Principal Component analysis have some features that are not very important when the variables tested have different units of measurement. Although there is nothing inherently wrong from a mathematical point of view, with linear combinations of variables with different units of measurement (wide use, for example, linear regression), the fact that PCA is defined based on variants that depend on the Covarians matrix. This can change the unit of measurement in one or more variables that change, unless all p variables experience scale changes, and in this case, the new Covarians matrix is only a multiple of the scale from the previous scale, so the eigenvector and the same proportion of variants are explained by each Principal Component)[6]. This standardization is arranged in the form of a matrix that Covarians will look for which is a correlation matrix from the original data (before standardization).

E. Standard Value Decomposition (SVD)

Standard Value Decomposition in Principal Component Analysis is performed if the calculation of data uses a correlation from the original data matrix. Standard Value Decomposition calculations using eigenvectors are sought based on the correlation of the original data matrix. [6].

III. Methods

This research consists of two main parts:

1. Preparation of the questionnaire is divided into two, namely demographic questionnaire to find out information about participants (age, gender, education level, frequency of smartphone use) and user-perception questionnaire (user-perception) which is included in the User Engagement Scale (UES).
2. Existing data is then arranged using variables. The arrangement of the variables will be broken down into multidimensional and unidimensional according to the test scale that will be used in this study on the grounds that the variables on the multidimensional scale will be further tested using Principal Component Analysis (PCA). PCA analysis is used to determine the level of convenience and standardize the scale matrix used.

IV. Results and Discussion

Some of the results obtained in this study include the following questionnaire items and iteration of testing results.

A. Preparation of Questionnaire Items

The research began with the preparation of the Questionnaire. This questionnaire was prepared by determining the items that support the measurement of user engagement scale.

The items used in the User Engagement Scale questionnaire consist of a User Engagement measuring variable which amounts to 31 statement items arranged with six indicators with one indicator represented with three to eight statements applied to the questionnaire

Respondents in this study were the target users of the BidFish application, so that a sample of 47 people was obtained for the auction application, consisting of the direct auction actors around Muara Angke. From the questionnaire distributed using hardcopy, a total of 47 questionnaire answers were collected, which means that the target respondents answered and returned all the questionnaires distributed. From 47 questionnaire respondents, there were 38 respondents (81%) with male gender, and there were 9 respondents (19%) with female gender.

The arrangement of the variables will be broken down into multidimensional and unidimensional according to the test scale that will be used in this study on the grounds that the variables on the multidimensional scale will be further tested using Principal Component Analysis.

To evaluate the validity, the authors use the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity while helping in the process of reducing data using Principal Component Analysis.

From testing the validity and correlation of Kaiser-Meyer-Olkin Measure of Sampling Adequacy, there are things that require several iterations to be able to fulfill the Principal Component Analysis requirements, namely the value of Measures of Sampling Adequacy in the correlation table is> 0.5, if there are indicators that have values <0.5, the indicator must be eliminated and the test must be repeated without including the indicator. In the first test the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity, it was found several values in the Measure of Sampling Adequacy correlation table that did not meet the requirements so that it was performed several iterations until the results met the requirements.

B. Validity Testing

To evaluate the validity, the authors use the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity while helping in the process of reducing data using Principal Component Analysis.

From testing the validity and correlation of Kaiser-Meyer-Olkin Measure of Sampling Adequacy, there are things that require several iterations to be able to meet the Principal Component Analysis requirements, namely the value of Measures of Sampling Adequacy in the correlation table is > 0.5, if there are indicators that have values < 0.5, the indicator must be eliminated and the test must be repeated without including the indicator[8],[9]. The first test of Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity produces some values in the correlation table of Measure of Sampling Adequacy that do not meet the requirements and then do a few iterations until the results meet the requirements.

C. KMO-MSA-Bartlett Testing on User Engagement Scale

TABLE I. UES VALIDITY TESTING ITERATION (FOR AUCTIONEER APPLICATION)

Iteration	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Signifikansi Bartlett's Test of Sphericity
1st Iteration	0.525	.000
2nd Iteration	0.744	.000
3rd Iteration	0.800	.000

In Table I, three times of iterations have been carried out to measure the amount of Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity because in testing, there are still many indicators that have a MSA correlation < 0.5. Table 1 shows that all the questionnaires tested were valid with a magnitude > 0.5 and significance < 0.5, and their value improved with each iteration.

TABLE II. UES MSA CORRELATION ITERATION (FOR AUCTIONEER APPLICATION)

Indicator	MSA Correlation		
	1st Iteration	*2nd Iteration*	*3rd Iteration*
FA1	0.411[a]	Eliminated	Eliminated
FA2	0.319[a]	Eliminated	Eliminated
FA3	0.503[a]	0.373[a]	Eliminated
FA4	0.512[a]	0.943[a]	0.931[a]
FA5	0.571[a]	0.643[a]	0.652[a]
FA6	0.816[a]	0.876[a]	0.861[a]
FA7	0.838[a]	0.769[a]	0.695[a]
PUS1	0.480[a]	Eliminated	Eliminated
PUS2	0.477[a]	Eliminated	Eliminated
PUS3	0.746[a]	0.695[a]	0.664[a]
PUS4	0.542[a]	0.723[a]	0.875[a]
PUS5	0.647[a]	0.792[a]	0.864[a]
PUS6	0.506[a]	0.725[a]	0.798[a]
PUS7	0.260[a]	Eliminated	Eliminated
PUS8	0.733[a]	0.814[a]	0.801[a]
AA1	0.408[a]	Eliminated	Eliminated
AA2	0.465[a]	Eliminated	Eliminated
AA3	0.569[a]	0.832[a]	0.838[a]
AA4	0.489[a]	Eliminated	Eliminated
AA5	0.473[a]	Eliminated	Eliminated
NO1	0.427[a]	Eliminated	Eliminated
NO2	0.663[a]	0.753[a]	0.725[a]
NO3	0.808[a]	0.804[a]	0.840[a]
FI1	0.240[a]	Eliminated	Eliminated
FI2	0.416[a]	Eliminated	Eliminated
FI3	0.764[a]	0.744[a]	0.768[a]
EN1	0.414[a]	Eliminated	Eliminated
EN2	0.707[a]	0.605[a]	0.757[a]
EN3	0.311[a]	Eliminated	Eliminated
EN4	0.438[a]	Eliminated	Eliminated
EN5	0.810[a]	0.786[a]	0.859[a]

Table II shows the results of the iteration of Measures of Sampling Adequacy. The first iteration shows that indicators FA1, FA2, PUS1, PUS2, PUS7, AA1, AA2, AA4, NO1, FI1, FI2, EN3, EN4 appear to have values < 0.5, which indicators do not have correlations that meet the requirements and must eliminated. Testing must be repeated by not including these indicators.

Then in the second iteration, Measures of Sampling Adequacy on the FA3 indicator turned out to have a value of < 0.5 in which the indicator does not have a correlation that meets the requirements and must be eliminated. Testing must be repeated again by not including the indicator.

Then in the third iteration, the last iteration, the Measures of Sampling Adequacy of all indicators are at a value of > 0.5, where all indicators have correlations that meet the PCA testing requirements.

D. Principal Component Analysis Testing

Principal Component Analysis is used to reduce dimensions to one factor component that represents all dimensions in one variable. Principal Component Analysis testing is carried out using data that has been tested for validity with the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

However, before proceeding to the Principal Component Analysis test, there are things that require several iterations to be able to fulfill the Principal Component Analysis requirements, namely the conditional Communalities value of > 0.5.

Communalities are variants contributed by a variable with all other variables in the analysis. If there are indicators that have a value < 0.5, the indicator must be eliminated and the test must be repeated by not including the indicator, as was done in the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity tests.

E. PCA on Engagement (User Engagement Scale)

Principal Component Analysis is used to reduce dimensions to one factor component that represents all dimensions in one variable. Principal Component Analysis testing is carried out using data that has been tested for validity with the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

However, before proceeding to the Principal Component Analysis test, there are things that require several iterations to be able to fulfill the Principal Component Analysis requirements, namely the conditional Communalities value of > 0.5.

Communalities are variants contributed by a variable with all other variables in the analysis. If there are indicators that have a value of < 0.5, the indicator must be eliminated and the test must be repeated by not including the indicator, as

was done in the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity tests.

a) Communality Testing

In PCA testing on the User Engagement Scale, iterations are performed twice after KMO-MSA-Bartlett's Test, because some indicators do not have communalities that meet the requirements.

TABLE III. UES COMMUNALITIES (FOR AUCTIONEER APPLICATION)

Indicator	MSA Correlation	
	1st Iteration	*2nd Iteration*
FA4	0.397	Eliminated
FA5	0.206	Eliminated
FA6	0.347	Eliminated
FA7	0.027	Eliminated
PUS3	0.362	Eliminated
PUS4	0.394	Eliminated
PUS5	0.731	0.857
PUS6	0.574	0.748
PUS8	0.451	Eliminated
AA3	0.466	Eliminated
NO2	0.230	Eliminated
NO3	0.304	Eliminated
FI3	0.564	0.627
EN2	0.478	Eliminated
EN5	0.455	Eliminated

Table III shows the iterations that occur to obtain the value of communalities that meet PCA requirements. In the first iteration, indicators FA4, FA5, FA6, FA7, PUS3, PUS4, PUS8, AA3, NO2, NO3, EN1, EN2, EN5 do not have sufficient communalities, which means they do not have variants that can affect the whole in the Engagement variable, and these indicators must be eliminated and retested

In the second iteration, there are 3 indicators left, namely PUS5, PUS6 and FI3. All indicators meet the Communalities requirements and already have a value> 0.5 so that testing can proceed.

b) Component Analysis based on Eigenvalues

TABLE IV. UES EIGENVALUE (FOR AUCTIONEER APPLICATION)

Component	Eigenvalue		Extraction from all loading factors	
	Total	*Variance (%)*	*Total*	*Variance (%)*
1	2.232	74.411	2.232	74.411
2	0.549	18.316		
3	0.218	7.273		

Table IV explains the amount of variance that can be explained by the analyzed factors. If there is a total eigenvalue whose value is less than 1, that factor is declared unable to explain the variable properly, so it is not included in the formation of the variable.

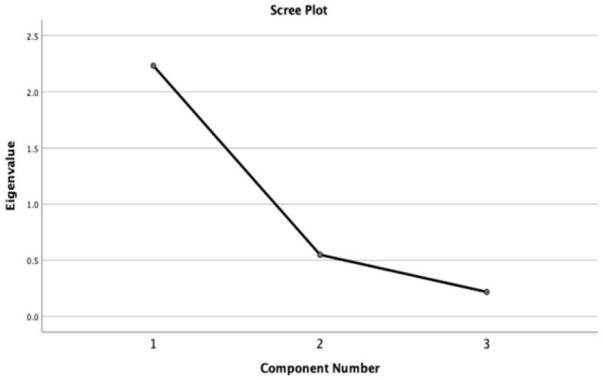

Fig. 1. Scree Plot UES (Auctioneer Application).

Based on the initial eigenvalue value that has reached the value of > 1, one component of the results is obtained from PCA. The component can explain 74,411% of all variables, and will represent the Engagement variable in hypothesis testing. This is shown in the Scree Plot scheme. Scree plot shows eigenvalue as a function of many factors, in an extraction effort. The form of the scree plot is used to determine the number of factors.

TABLE V. COMPONENT MATRIX (FOR AUCTIONEER APPLICATION)

Indicator	Component Matrix Value
PUS5	0.926
PUS6	-0.865
FI3	0.792

Table V shows the component matrix of the components that have been successfully extracted. Based on this table, the most influential indicators on the Engagement variable are PUS5 and FI3 with the largest values namely 0.926 and 0.792, and these are indicators that represent the Engagement variable (Perceived Usability and Felt Involvement).

After a PCA analysis was performed on the User Engagement Scale questionnaire to measure User Engagement in the BidFish application (hereinafter referred to as the Engagement variable), a factor score was extracted from the PCA. Furthermore, it was found that the Engagement variable has the 2 most influential dimensions in this test, namely Perceived Usability and Felt Involvement. This can show how well these dimensions affect the entire test variable. Perceived Usability and Felt Involvement have the most influential variants on all variables and are considered to be able to explain the overall dimensions of the variables quite well, so that the score of the extracted factor is the component that contains both dimensions.

V. CONCLUSION

The results of data processing in this study indicate that Usability has a significant positive effect on the Engagement variable. It can be perceived that if the BidFish application has

a high level of usability, is easy to learn, has a high level of efficiency, is easily remembered and recognized by the user, it will affect the affective and cognitive response of the user to the system due to its attractive appearance, affecting the feelings felt by the user when accessing the BidFish application, and will make users satisfied with all the features available on the system.

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